CHAPTER 5.—BLEEDER SYSTEMS IN UNDERGROUND COAL MINES

By John E. Urosek, P.E.,[1] William J. Francart, P.E.,[2] and Dennis A. Beiter[3]

In This Chapter

- ✓ Designing bleeder systems
- ✓ Examining and maintaining bleeder systems
- ✓ Evaluating bleeder system effectiveness

INTRODUCTION

Bleeder systems are that part of the mine ventilation network used to ventilate pillared areas in underground coal mines. Pillared areas are those in which pillars have been wholly or partially removed, including the areas where coal has been extracted by longwall mining. Bleeder systems protect miners from the hazards associated with methane and other gases, dusts and fumes, and oxygen deficiency that may occur in these mined-out areas. Effective bleeder systems control the air passing through the area and continuously dilute and move any methane-air mixtures and other gases, dusts, and fumes from the worked-out area away from active workings and into a return air course or to the surface of the mine. A bleeder system includes the pillared area (including the internal airflow paths), bleeder entries, bleeder connections, and all associated ventilation control devices that control the air passing through the pillared area. Bleeder entries are special air courses designed and maintained as part of the mine ventilation system.

This chapter focuses on the design, examination, maintenance, and evaluation of bleeder systems in underground coal mines.

The history of coal mine explosions in the United States is a reminder of the importance of adequate ventilation. Some of those disasters were the result of inadequately ventilated pillared areas. The importance of developing bleeder systems to ventilate these pillared areas and evaluating the bleeder system's effectiveness is reflected in present-day federal regulations. For more information on bleeder systems, see Tisdale [1996] and Urosek and Francart [2002].

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[1]Chief, Ventilation Division, Pittsburgh Safety and Health Technology Center, Mine Safety and Health Administration, Pittsburgh, PA.
[2]Mining engineer, Ventilation Division, Pittsburgh Safety and Health Technology Center, Mine Safety and Health Administration, Pittsburgh, PA.
[3]Supervisory mining engineer, Ventilation Division, Pittsburgh Safety and Health Technology Center, Mine Safety and Health Administration, Triadelphia, WV.

DESIGNING BLEEDER SYSTEMS

As part of the mine ventilation system, bleeder systems should be addressed in the overall mine design. Designing a good bleeder system requires consideration of ground control and pillar design, strata characteristics, contaminant liberation, airflow distribution, and the internal workings of the bleeder system. When bleeder systems are incorporated into an existing mine ventilation system, the capacity of that ventilation system should be considered.

There are two basic design classifications for bleeder systems used in U.S. coal mines: wrap-around and flow-through. Although there are many variations, the concept by which they all function is the same.[4] A ventilating pressure differential is established from the active workings, across the pillared area, to the bleeder and/or return entries. Sufficient connections are established between the pillared area and these entries for the airflow to be induced and distributed through the pillared area by the applied ventilating pressure differential. Gases in the pillared area are diluted and moved away from the active workings by the airflow induced through the pillared area. The applied ventilating pressure is that pressure which actually causes the airflow. The primary difference between the two designs is the means used to maintain the pressure differential across the pillared area.

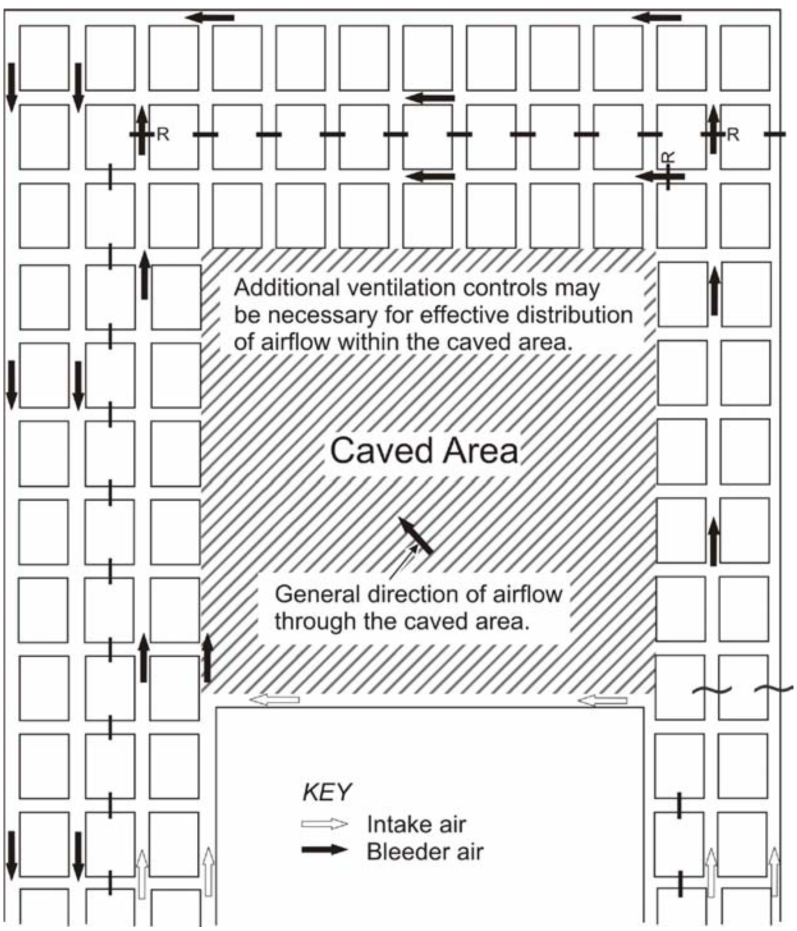

Figure 5–1.—Simplified illustration of a wrap-around bleeder system for a longwall panel.

Wrap-around system designs rely completely upon ventilation controls constructed between the pillared area and bleeder entries to establish the ventilating pressure differential. Numerous ventilation controls located close to the pillared area are often necessary with this design. The additional ground pressures from the pillared area increase the susceptibility of these ventilation controls to damage. Figure 5–1 is a simplified illustration of a wrap-around system for a longwall panel. Flow-through systems use solid coal barriers in conjunction with ventilation

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[4]Some unique systems have been developed for ultragassy mines affected by spontaneous combustion. These special cases are not be covered in this chapter.

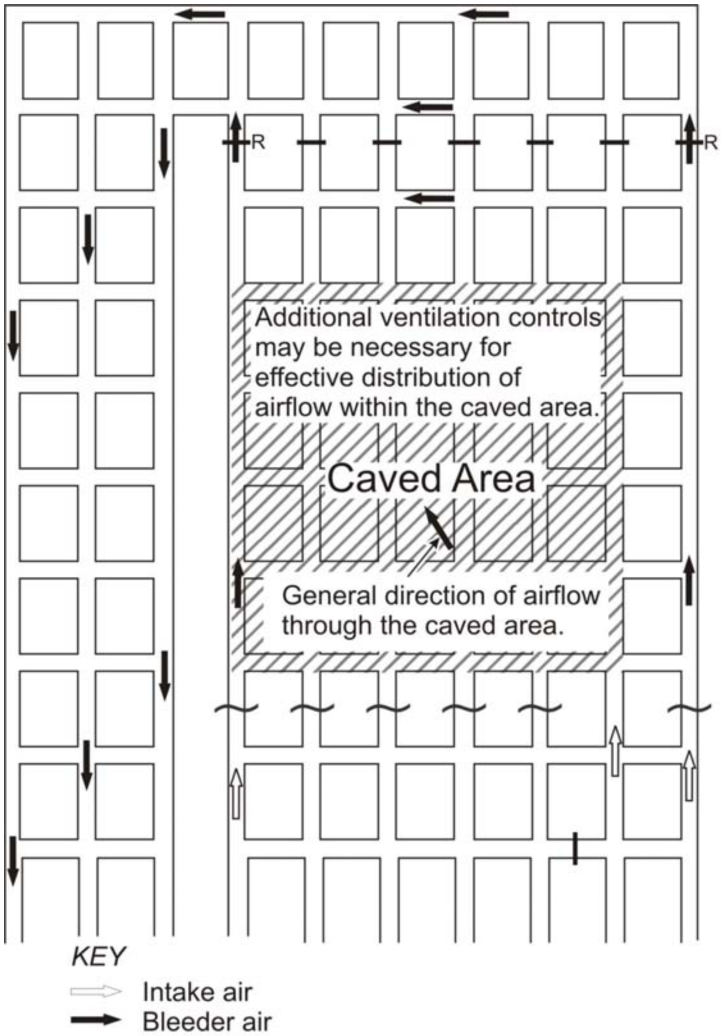

Figure 5–2.—Simplified illustration of a flow-through system with bleeder entries.

controls to maintain a pressure differential across the pillared area. Figure 5–2 is a simplified illustration of a flow-through system with bleeder entries. The coal barriers replace many of the ventilation controls and can provide additional protection for the bleeder entries from the ground pressures created as a result of extracting the coal pillars. These simplified illustrations do not show all of the ventilation controls sometimes necessary to direct the airflow, nor do they show the additional multiple entries that may be necessary to carry the required quantity of air.

Ground control and pillar design. Ground control and pillar design are critical to the overall stability of bleeder systems. Some factors to be considered include mining parameters (e.g., mine opening dimensions, pillar size, panel size, bleeder geometry, and intersection dimensions), overburden and horizontal stresses, roof control systems, and multiple-seam interaction. Irregular shapes in the bleeder system that concentrate abutment loads generally require additional attention. Ground pressures developed as a result of mining can be magnified in such areas and may necessitate additional support.

The life expectancy of the bleeder system must be considered during the design process. The necessity of maintaining access and protecting primary internal airflow paths within the pillared area cannot be overstated. The long-term nature of bleeder entries and their close proximity to pillared areas usually require that supplemental roof support be installed in them. The additional support should be installed in advance of overburden stresses from pillaring because, typically, limited access to bleeder entries makes remedial actions difficult or impossible.

Roof support requirements are mine-specific. Wood cribbing has long been recognized as an appropriate supplemental roof support for many bleeder systems. Technology and innovative design have provided alternative materials. Concrete donuts, canned cribs, pumpable supports, yielding posts, metal supports, cable bolts, and trusses have been used.

Caved area characteristics. The characteristics of the caved material and the overlying strata in areas where pillars have been extracted are influenced by several factors. These include the geology of the roof strata, the degree of extraction, and the distance between supporting pillars. Mining method and percentage of pillar recovery greatly affect the strata response to the extraction. Increased extraction generally results in less permeable caved areas. If the main roof subsides, compaction of the caved material occurs and decreases void space and permeability. Compaction occurs in the caved areas created by most longwalls. The limited void space and decreased permeability of compacted caved areas limits the volume of gases that can accumulate in the rubble of the caved area and diminishes their interaction with mine airstreams.

Contaminant liberation. Estimation of liberation rates for gaseous contaminants, such as methane and carbon dioxide, is an important factor in determining ventilation requirements. However, this can be difficult to determine prior to mining when no liberation history has been developed. Even with historical data available for the engineer to use, other factors must be considered. The source of the contaminants is one factor that can impact the bleeder system design. Some mines considered to be very gassy produce significant methane volumes only while cutting coal. In other gassy mines, a majority of the methane is liberated when the strata are broken due to second mining. Fractures caused by caving in the pillared area can permit methane and other contaminants to enter the mine from overlying and underlying mines as well as from the surrounding strata. Contaminants are also liberated from the coal ribs of the bleeder entries. Another factor is the relationship between the size of the pillared area and the total volume of contaminants liberated. Liberation of contaminants can increase as the pillared area increases in size. Although methane is the primary contaminant in many mines, carbon dioxide can also be a concern.

A relationship exists between production rates and methane liberation in most mines. Increased production rates result in increased methane liberation, both in the face area and the pillared area. Contaminants in the face ventilation airflow directed into the pillared area will also impact the bleeder system. Bleeder system design that addresses the capacity to dilute contaminants such that production need not be curtailed is prudent and reduces the potential for exceeding the dilution capacity of the system.

In some gassy mines, vertical degasification boreholes have been used effectively to reduce the methane to be diluted by underground bleeder systems. Horizontal degasification boreholes have been used to drain methane from the coal seam in advance of mining and can assist in reducing ventilation requirements during development as well.

Oxidation within the pillared area, as well as contaminants liberated from the strata, can contribute to oxygen deficiency. Oxygen deficiency in the bleeder entries and at measurement point locations can impede continued access to examination locations needed for evaluating bleeder system effectiveness. Consideration must be given to providing sufficient airflow through the pillared area and bleeder entries to prevent oxygen deficiency so that the bleeder entries and measurement point locations are maintained safe for access.

Airflow distribution. The bleeder system should be designed such that the pillared area is continuously under the influence of mechanical ventilation that will induce the necessary quantities of airflow in the intended direction. The design should preclude air that has ventilated the pillared area from flowing toward or by the working section. The bleeder system must continuously control and distribute airflow through the area.

Airflow distribution and ventilation capacity affect dilution of contaminants. Proper distribution of airflow through the bleeder system facilitates dilution of the contaminants and minimizes the possibility of accumulations of methane and other contaminant gases. Managed airflow distribution requires openings, including primary internal airflow paths within the pillared area, bleeder connectors, and bleeder entries that function for the duration needed. Connections with the pillared area provide inlets and outlets through which the airflow is distributed and enable gathering of information used in evaluating the effectiveness of the airflow distribution.

Airflow is controlled using ventilation controls and mine layout. Standard construction techniques, considering the life of the system and the conditions anticipated, should be adopted for ventilation controls in the bleeder system. Some types of controls, such as curtains, are more susceptible to damage by the mine environment or inadvertent change by mine personnel. Unplanned changes may adversely impact bleeder system effectiveness. Critical controls should remain accessible because adjustments are usually necessary throughout the life of a system. Removal of unneeded ventilation controls decreases the likelihood that they will cause unintentional restrictions.

Internal workings of the bleeder system. It is recognized that the characteristics of individual pillared areas vary. However, the primary internal airflow paths of many bleeder systems are the remaining development entries and crosscuts between and around the caved material in the pillared area and the perimeter of the caved area. Except for the perimeter, airflow across and through much of the caved area generally occurs only to a limited degree unless the permeability of the caved material is high and/or the applied ventilating pressure is large. With contemporary bleeder system designs, inclusion and support of mine entries within the pillared area often are necessary to provide internal airflow paths through which air will continually pass to dilute and carry the contaminant gases away from the active areas and into bleeder and/or return entries or directly to the surface.

In longwall bleeder systems, the ventilation of the longwall face area cannot be separated from the bleeder system. In longwall panels where caving has occurred, the amount of air flowing across the face directly impacts the airflow passing through the parallel primary internal airflow path immediately behind the shields. Increased longwall face airflow results in better dilution and removal of contaminants in this critical portion of the pillared area closest to the face.

Loss of the primary internal airflow paths that provide a direct conduit from the active workings can compromise bleeder system effectiveness and the ability to evaluate the system's effectiveness. Although some of the contaminant gases may continue to be moved away from the active areas, insufficient airflow through the primary internal airflow paths may result in accumulations of hazardous gas concentrations in close proximity to active areas, such as locations behind the shields in longwall systems or other open areas near the face. A roof fall or air reversal could then move this gas into the active area. Because of limited access, it may not be possible to determine the extent of the accumulation or how close it is to the active areas. The failure to adequately address the internal workings of the bleeder system may result in hazardous conditions for miners.

Capacity of the ventilation system. The total ventilation resistance of the pillared area of a bleeder system depends not only on the permeability of the caved material, but also on the size and shape of the pillared area, including the length and integrity of the primary internal airflow paths through and around the caved material. As the pillared area increases in size or age, the resistance of the primary airflow paths generally increases. Experience has shown that significant changes to the resistance of primary internal airflow paths can even occur during the mining of one panel.

The mine ventilation system must maintain a ventilating pressure able to overcome the resistance in the bleeder system and sustain airflow. The importance of a reserve ventilating pressure capacity, as evidenced by the regulation of the air splits, was recognized by ventilation engineers over 30 years ago. The reserve ventilating capacity provides flexibility to increase airflow when needed and to provide additional ventilating pressure differential across the pillared area [Kalasky and Krickovic 1973].

Recent trends in longwall mining require more emphasis on the ability of the ventilation system to provide and maintain greater ventilating pressure differentials across the pillared areas of bleeder systems. Individual longwall panels are increasing in length and width, the number of development (gate) entries is decreasing, and the number of connected panels in an individual bleeder system is increasing. The result is higher resistance airflow paths and extended longevity. Both often result in greater ventilation requirements. Thus, the need for designing bleeder systems with sufficient reserve ventilating pressure capacity is vital.

Ventilating pressure is an important consideration in the design of all bleeder systems. In some mines, the main mine fan can provide adequate airflow for the bleeder system. Other mine operators have found that incorporating bleeder shafts and high-pressure bleeder fans into flow-through bleeder systems with bleeder entries is necessary to meet the required capacity of today's larger systems, especially in mines with high methane liberation rates. But even these high-pressure exhaust fans have limitations. Applying ventilating pressure differential in itself is not the equivalent of effectively ventilating the pillared area. Airflow is necessary to dilute and carry away the contaminants. Accumulations of hazardous gases can still develop if sufficient airflow is not continuously diluting and carrying away the contaminants.

Other factors also impact bleeder system capacity. The configuration of some bleeder systems can severely limit ventilating capacity. The resistance of the airflow paths within the bleeder system must be considered. Compared to multiple entries, pressure losses in single bleeder entries will reduce the ventilating pressure available to move air through the pillared area. Ventilating pillared areas such that the ventilating pressure is applied in opposing directions may have adverse impact on both the airflow through the internal workings of the bleeder system and the ability to evaluate the system performance. Additional splits of air directed into the bleeder entries, for the purpose of ventilating electrical installations and dewatering systems or to provide greater access, displaces bleeder airflow and may eliminate a bleeder entry that could otherwise carry bleeder airflow. Finally, leakage from splits of air located adjacent to bleeder airflow can impact the system capacity, including its ability to dilute contaminants from the pillared area.

Water drainage. The design of the bleeder system should include the means to prevent water accumulations that might cause obstructions. The mine water drainage infrastructure should be installed before pillar mining limits access to an area. Consideration should also be given to preventing water accumulations within the pillared area that could impact bleeder system effectiveness. A mine layout that considers anticipated mine floor elevations can impact the drainage of water in the bleeder system.

Sealing. Bleeder systems should be designed to provide ventilation and enable evaluation of system effectiveness for the anticipated life of the system. Realistic consideration of the size and number of panels and the length of time that ventilation can be provided and the bleeder system can be evaluated is essential. Prudent mine operators limit the size and age of the bleeder system before a decline in system performance or an inability to evaluate the system necessitates sealing. If it is determined that the bleeder system is not effective or it cannot be determined that the bleeder system is effective, the worked-out area must be sealed. The ability to seal the pillared area ventilated by the bleeder system must be considered in the design process. Federal regulations require that each mining system be designed so that each worked-out area can be sealed. The location and the sequence of construction of proposed seals are required to be specified by federal regulations.

EXAMINING AND MAINTAINING BLEEDER SYSTEMS

Weekly examination requirements for bleeder systems are specified in 30 CFR[5] 75.364.

Examinations provide the means of collecting the information needed to evaluate bleeder system effectiveness. 30 CFR 75.364 specifies the minimum requirements for the examination of bleeder systems. Weekly examinations are required at all locations where air enters the worked-out area (inlets) and in the bleeder system airflow immediately before the air enters a return split of air (outlets). Measurements of methane and oxygen concentrations and of air quantity and a test to determine if the air is moving in its proper direction are to be made at all the locations.

During the weekly examinations, at least one entry of each set of bleeder entries is to be traveled in its entirety. Measurement point locations at which examinations are to be made are required to be specified in the ventilation plan. These locations are not in lieu of traveling the bleeder entries, but rather are the locations within the bleeder system, in addition to the inlets and outlets, where the examiner will measure the methane and oxygen concentrations and air quantities and

[5]*Code of Federal Regulations.* See CFR in references.

perform tests to determine whether the air is moving in the proper direction. Knowledge of the specific conditions of each mine and an understanding of how the system functions, including the internal airflow patterns, are necessary when considering specific measurement point locations. Examinations should also evaluate the condition of ventilation controls critical to the proper function of the bleeder system. Provisions exist for an alternative method of evaluation to be specified in the ventilation plan, provided it results in proper evaluation of the effectiveness of the bleeder system.

Mine examiners or persons working or traveling in remote areas, especially in bleeder entries, should always be on the alert for changing conditions, such as accumulations of methane or oxygen-deficient air. Persons should not enter connectors and the pillared area unless they are well-informed about the areas to be entered, have sufficient detection instruments, and have discussed their intent with other persons who will then know their whereabouts.

Some mine operators have increased the frequency of monitoring the air quality and quantity at examination locations by installing sensors connected to the central atmospheric monitoring system. In this way, the mine operator can continuously monitor and record this important information. Sensors for methane, oxygen, carbon monoxide, and air velocity have been installed to enhance the evaluation of the ventilation system.

Maintenance of bleeder systems can directly impact system effectiveness and/or the ability to determine the effectiveness of the bleeder system. Failure to provide and maintain adequate control of the ground conditions often results in roof falls and floor heave. Failure to provide and maintain a means to control water often results in water accumulations. The most significant consequences of roof falls and water accumulations are the potential for reducing or preventing airflow and preventing the completion of the examinations that are required to determine the system's effectiveness. Due to access limitations and practical constraints, deteriorated conditions and obstructions may not be possible to remediate. These same types of conditions and obstructions may impact the primary internal airflow paths as well, with fewer or no options to remediate. Thus, the need to prevent obstructions within a bleeder system through adequate preventive measures cannot be overstated.

The records that federal regulations require to be maintained concerning the weekly examinations include the results of particular tests and measurements and notations for hazardous conditions observed. Other information not required can also be beneficial. Notes, records, or communications of pertinent information made by the examiner can be useful in determining whether problems are developing in the bleeder system. This information includes changes in water levels and their locations, roof conditions, floor heave, pillar and roof deterioration, and damage or deterioration of important ventilation controls.

Roof fall and water accumulations in bleeder entries have contributed to many serious accidents involving coal mine bleeder systems. In one incident, an accumulation of water was a major reason that a mine examiner did not travel the bleeder entries of a room-and-pillar wrap-around bleeder system. The examiner determined that water had begun to accumulate in a corner of the bleeder system. A month later, water had risen to a depth considered by the examiner to be too hazardous through which to travel. Consequently, the bleeder entries were examined only to the edge of the water. Roof falls in the bleeder entry were not addressed. As a result, the effectiveness of the bleeder system was not evaluated. The bleeder system became ineffective and failed to properly remove methane from the mined-out area. Methane accumulated in the mined-out area just inby the retreat section pillar line. Removal of ventilation controls on the retreat section permitted movement of the accumulated methane to the active workings, where it was ignited. Ten miners were fatally injured in the ensuing explosion.

EVALUATING BLEEDER SYSTEMS

Examiners, inspectors, and engineers should be trained to evaluate bleeder systems and recognize deficiencies. As they inspect or analyze a bleeder system, they must be able to recognize hazardous conditions and take appropriate action. They must have knowledge of the three basic factors governing the ventilation of mines: ventilating pressure, airflow, and air quality. In addition, they must have an understanding of the particular bleeder system they are examining or evaluating, including airflow directions and air quantities, as well as normal methane or other critical gas concentrations; the location of potential problems from inadequate roof support or water accumulation; and the location of critical ventilation controls. This knowledge provides a base of information with which to evaluate the importance of subtle changes from previous examinations and to recognize deteriorating conditions that might cause system failure.

Control and direction. A bleeder system must continuously control and distribute air throughout the system. Established airflow patterns enable collection of information that is important in evaluating the bleeder system's effectiveness. Effective bleeder systems maintain the established airflow patterns. At inlets, outlets, and in the bleeder entries, airflow should be sufficient to be readily discernible and be in the proper direction. Airflow direction within the pillared area should also be in the proper direction. A bleeder system that does not produce discernible airflow through the pillared area is ineffective. A bleeder system in which the airflow direction has changed should be scrutinized. The bleeder system may no longer be effective, or the ability to evaluate its effectiveness may have been adversely impacted. Additional information may be needed to evaluate the bleeder system's effectiveness.

Air quality. Air quality is another essential consideration in determining bleeder system effectiveness. The primary air quality considerations for most bleeder systems are: keeping methane concentrations to no greater than 2% in the bleeder split of air immediately before it joins another split of air, diluting methane concentrations elsewhere within the bleeder system, and maintaining oxygen and limiting carbon dioxide concentrations in areas where persons work or travel.

In some highly gassy mines, the air currents coming from the pillared area can contain methane concentrations higher than 2% and must be diluted by the air moving in the bleeder entry. As a practical matter, when methane in the air moving in the bleeder entries approaches 2%, it can no longer dilute additional methane, from the pillared area or that liberated into the bleeder entries, to the 2% limit. The bleeder system is no longer effective when methane concentrations in the bleeder split cannot be reduced to 2% before entering another split of air.

A major purpose of the bleeder system is to keep methane accumulations away from mining activities, including the primary airflow paths that provide a conduit to the active section. Accumulations of unusually high methane concentrations in locations other than small pockets, such as in a corner, in the interstices of the rubble material, or in a small roof cavity, indicate that changes to the bleeder system may be necessary.

Methane exists in the pillared area and must be diluted by the air currents within the bleeder system and not be allowed to accumulate in open areas. Explosive mixtures of methane in open entries or crosscuts can constitute imminent danger. Relevant considerations include the location and extent of the accumulation, potential ignition sources, the primary internal airflow paths that provide a conduit to the active areas, and the potential for explosive methane-air mixtures to move to active areas, including the working section. It is imperative for miner safety that the portions of the pillared area adjacent to the working section and the primary internal airflow paths providing a conduit to the active working section be free of methane to the extent that a pillar fall might displace, or air reversals might move, an explosive methane-air mixture to the working section. Several accidents have resulted from the ignition of methane accumulations that existed within the pillared area near the working section.

All possible sources of methane need to be considered carefully. For example, some coal seams liberate large amounts of methane continuously from virgin coal ribs. In some instances, barometric pressure changes may cause higher liberation from the mined-out area. However, a bleeder system with adequate pressure differentials and air distribution will not be substantially affected by normal barometric changes. Inactive panels in a mined-out area tend to liberate constant amounts of methane and in lesser quantities than active panels. Increases in methane concentration or reduction in airflows from older panels should be investigated to determine if the system is still functioning as designed. Factors influencing methane levels include coal production levels, the production day of the week, the gas-bearing characteristics of the strata near the active mining, the proximity of the last vertical methane degasification borehole, recent ventilation changes, and changes in barometric pressure. Changes or trends of deteriorating air quality at measurement point locations or other examination locations may indicate an ineffective bleeder system.

Usually, the oxygen concentration in the bleeder system is a problem only from the standpoint of the safety of persons making examinations or assigned to work in the bleeder system. However, oxygen deficiency found in traveled areas of the bleeder system may indicate insufficient airflow in the bleeder system and should be further investigated. In bleeder systems with insufficient airflow, oxygen deficiency may result in the inability to evaluate the effectiveness of the system. Oxygen deficiency could also present a hazard to the working section if the bleeder system is ineffective and allows a sizable volume of oxygen-deficient air to exist in the pillared area or bleeder entries near the working section. Persons inspecting or examining bleeder systems must be alert to locations where low levels of oxygen may exist. The oxygen concentration in areas of bleeder entries and mined-out areas where persons work or travel must be at least 19.5%. The carbon dioxide levels must not exceed 0.5% time-weighted average and 3% short-term exposure limit in areas of bleeder entries and mined-out areas where persons work or travel. Oxygen can be displaced by methane, especially in high spots or cavities above roof falls, where the buoyancy of methane can cause it to collect. Oxygen is depleted as coal, wood, or other organic materials oxidize. In mines that liberate small amounts of methane, low airflows could result in oxygen deficiency before elevated methane levels occur.

The information collected at the examination locations and recorded in mine records should be used in evaluating the effectiveness of the bleeder system. Trends can be monitored. However, a thorough understanding of the system is needed to fully assess bleeder system performance. In complex systems or those with which there are concerns over limited capacity or effectiveness, there may be times when an investigation beyond the regular examination locations, such as into the primary internal airflow paths, may be appropriate if an investigation can be conducted safely. Confirmation of the internal airflow patterns and assessment of the dilution of contaminants may be appropriate to ensure that the examination locations provide the necessary information and can also provide a better understanding of what the trends at specific measurement point locations reflect about the internal workings of the bleeder system.

Situational indicators. As bleeder systems change, some conditions can develop as a result of, or in response to, declining system performance. These circumstances often warrant closer scrutiny to determine the impact of the condition on bleeder system effectiveness. The location and number of the present measurement point locations should be reassessed as to the adequacy for providing sufficient information for evaluation. Routine changes in the bleeder system can also cause problems. Situations such as the following should raise the level of interest and caution of persons evaluating bleeder system effectiveness.

- *Separate mine fans*. Directing airflow from the pillared area to separate mine fans may diminish the pressure differential established across segments of the pillared area, sometimes resulting in poorly ventilated areas, unventilated areas, or complication of the evaluation of the bleeder system effectiveness. Similar problems can result when the airflow ventilating the face area is directed to a mine fan separate from the mine fan ventilating the pillared area. Some of the airflow ventilating the active face should always be directed into the pillared area to prevent unventilated areas of the pillared area close to the active working section. Depending on the configuration of the system and the control of the airflow in the system, similar problems can occur even when a single mine fan is ventilating the face area and the mined-out area.

- *Splits of air directed into the pillared area (other than the split ventilating the active working section).* Although other splits are often necessary and important to maintain ventilation of the pillared area, understanding the impact of introducing other splits on the bleeder system is important. Splits of air directed into the pillared area (other than the split ventilating the face(s) from the active working section) can decrease ventilating pressure across the pillared area and adversely affect airflow away from the active working section. Depending on ventilating pressure differentials, poorly ventilated areas may develop within the pillared area. Extreme conditions would be stagnation of the airflow entering the pillared area from the face area or the airflow from the mined-out area moving to or toward the active working section. The proposed introduction of other splits of air into the pillared area should be evaluated to predict what overall effect the change will have on the system. Following implementation of changes, the bleeder system should be evaluated through in-mine examinations to determine if the changes produced the expected results.

- *Inlets to the pillared area near locations where air exits from the pillared area*. Inlets to the pillared area near locations where air exits from the pillared area can mask the effectiveness of the airflow distribution and complicate or prevent evaluation of the bleeder system. This condition should be closely scrutinized and is generally discouraged.

- *Inlets to the pillared area from intake air courses*. The pressure differential that exists across regulators separating intake air courses from pillared areas should be sufficient to prevent air from the pillared area from entering the intake air courses due to normal mining activities that affect ventilating pressures in the area.

- *Splits of air separate from the bleeder split*. Small splits of intake air that are used to ventilate electrical installations are permitted to enter the bleeder airflow and do not generally affect the location of the regulatory 2% methane limit, assuming they have been determined to be insignificant in their effect on the bleeder split and ventilation of the pillared area. Leakage from separate splits of air located adjacent to bleeder airflow may improve the air quality in the bleeder entries while actually decreasing the ventilating capacity of the pillared area by reducing the available ventilating pressure and airflow quantity. A full consideration of the significance of separate splits of air located adjacent to bleeder airflow should include leakage from that split into the bleeder airflow. The location of the regulatory 2% methane limit in the bleeder split may be affected.

- *Startup and recovery ventilation*. The ventilation of the face and pillared area at the startup of both longwall and room-and-pillar systems is dynamic. Significant caving in the pillared area sometimes does not readily occur when retreat mining begins. Larger open areas often exist in the pillared area, and the primary internal airflow paths that will exist during mining of the majority of the panel are not fully established. The ability to maintain airflow on a longwall face can be impaired. The conditions often warrant close scrutiny of the distribution of the airflow through the pillared area until the primary internal airflow paths are established. Additional ventilation controls may be needed during this period to ensure adequate distribution of airflow.

  Setup and recovery of longwall face equipment is another critical time when close scrutiny is warranted. Airflow is often being redistributed in the bleeder system by mine management as the new longwall face is set up and equipment on the finished longwall face is recovered. Since methane liberation at the face decreases after production is stopped, longwall recovery faces are also often ventilated with decreased airflow quantities. That decrease in face airflow directly impacts the ventilation of the pillared area nearest the recovery area. Quality examinations are needed to ensure that the bleeder system is effective and that methane and other hazardous gases do not accumulate.

- *Changes in gas concentrations, ventilating pressures, and air quantities*. If examiners find rising methane concentrations with no changes in air quantities or pressures, then it can be concluded that methane liberation is increasing. Rising methane or decreasing oxygen levels with decreasing air quantities and ventilating pressures can indicate possible restrictions in the bleeder system. However, relying on just one parameter such as air quantity measurements without considering other related information can sometimes result in a misdiagnosis of the condition.

- *Dilution capacity of bleeder system less than contaminant production*. The ventilating capacity of a bleeder system is insufficient if it cannot dilute the amount of contaminants that can result from normal coal production. It can be difficult to assess the success of limiting production as a corrective action when the capacity to produce coal results in the production of more contaminants than the bleeder system can adequately dilute. The full effect of excessive coal production cannot be readily assessed in a bleeder system. Because of the delay between when methane is liberated and when it exits the pillared area, methane can accumulate in the pillared area of a system with insufficient capacity before it can be detected at examination locations. This can also result in a continuing increase of methane concentration at examination locations after mining has ceased. Ceasing production after changes are detected does not have the same impact as decreasing the capable production rate because contaminants have accumulated before detection is possible. This process can result in repetitious excursions beyond the bleeder system's capacity to safely dilute contaminants. Such repeated excursions indicate an ineffective bleeder system. A more appropriate response would be to improve the capacity of the bleeder system. Because of inadequate planning, some mine operators have had to resort to sinking bleeder shafts, installing bleeder fans, and drilling degasification boreholes as remedial measures to improve the capacity of existing bleeder systems.

A bleeder system should be designed to provide adequate ventilation of the pillared area at the maximum expected coal production rate.

- *Reserve ventilating pressure relative to the applied ventilating pressure*. The magnitude of the applied ventilating pressure across the pillared area is often not easily determined. The applied ventilating pressure cannot usually be determined merely from a measure of the pressure differential across ventilation controls. This information can be obtained from altimeter surveys or tube and pressure gauge surveys. Knowledge of the magnitude of the applied ventilating pressure is useful in assessing the capacity of the reserve ventilating pressure. This ventilating pressure can be compared with the pressure differentials across regulators controlling airflow through the pillared area. Some mine operators have installed permanent pressure measurement stations at these locations.

- *Confusing examination records*. Organization of the examination records greatly improves the ability to adequately consider the information collected when evaluating bleeder system effectiveness. If the examination records seem unorganized or the information specific to the bleeder system is difficult to collectively review, changes that have occurred in the bleeder system are not as easily observed or evaluated.

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